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(54) **QUICK-CONNECT COUPLING**

(56) **References Cited**

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U.S. PATENT DOCUMENTS

68,567 A \* 9/1867 Furbish ..... 168/45  
685,677 A \* 10/1901 Furbish ..... B23B 31/1253  
279/22

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2,255,333 A 9/1941 Scheiwer  
2,255,695 A 9/1941 Bull  
3,190,168 A 6/1965 Sullivan

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(Continued)

FOREIGN PATENT DOCUMENTS

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DE 1108528 6/1961  
DE 1108528 B 6/1961

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(Continued)

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OTHER PUBLICATIONS

Final Office Action dated Oct. 16, 2014 for U.S. Appl. No. 13/449,821.

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(57) **ABSTRACT**

A quick-connect coupling for connecting an exchangeable head to a pressing device has balls K1 with a diameter D1, which are radially movably disposed in a ball-holding part on the pressing device. Balls K1 being held radially fixed in a groove on the head with a depth N1 by a locking ring in the connected state. The head has a further peripheral groove with a depth N2. The further groove is designed to hold part of further balls K2 with a diameter D2, wherein the balls K2 are likewise disposed in a radially movable manner in the ball-holding part and wherein the diameter D2 is greater than the diameter D1. The diameter D1 is the same or smaller than the difference between the diameter D2 and the groove depth N2.

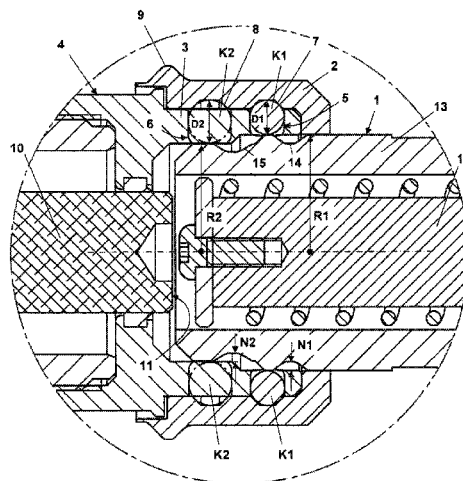
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See application file for complete search history.

**18 Claims, 5 Drawing Sheets**



(56)

**References Cited****U.S. PATENT DOCUMENTS**

3,583,715	A	6/1971	Jarhl
3,937,055	A	2/1976	Caruso et al.
3,947,047	A	3/1976	Hultman
4,107,949	A	8/1978	Wanner
4,111,592	A	9/1978	Schnitzler
RE31,755	E	12/1984	Wanner
5,003,847	A	4/1991	Wagner
5,209,153	A	5/1993	Araki et al.
5,253,554	A	10/1993	Riera et al.
5,730,022	A	3/1998	Hansson et al.
5,957,634	A	9/1999	Carpinetti
6,290,606	B1	9/2001	Hodson
6,324,768	B1	12/2001	Wellman
6,324,884	B1	12/2001	Barjesteh et al.
6,461,089	B2	10/2002	Adrian et al.
6,511,268	B1	1/2003	Vasudeva
6,718,870	B1	4/2004	Frenken
6,953,196	B1	10/2005	Huang
7,140,817	B1	11/2006	Phillips et al.
7,520,495	B2	4/2009	Stark
7,641,415	B2	1/2010	Fox et al.
7,839,053	B2	11/2010	Hamasaki et al.
8,636,287	B2*	1/2014	Wienhold ..... 279/75
9,242,422	B2	1/2016	Schweizer
2002/0017753	A1	2/2002	Adrian et al.
2004/0161313	A1	8/2004	Nordlin
2005/0120770	A1	6/2005	Frenken
2007/0063403	A1	3/2007	Stark
2009/0290931	A1	11/2009	Blanchard
2010/0005849	A1	1/2010	College
2012/0319398	A1	12/2012	Schweizer et al.
2012/0319399	A1	12/2012	Schweizer
2014/0260505	A1	9/2014	Bowles et al.

**FOREIGN PATENT DOCUMENTS**

DE	2426760	A1	1/1975
DE	2614531	A1	10/1976
DE	2551125		5/1977
DE	2551125	A1	5/1977
DE	2614532	B1	9/1977
DE	20012706	U1	9/2000
DE	10046869	A1	4/2002
DE	20312887	U1	10/2003
DE	203128287		10/2003

DE	202009010128	U1	10/2009
EP	0253177		1/1988
EP	1084798		3/2001
EP	1084798	A2	3/2001
EP	1244187		9/2002
EP	2535128		12/2012
FR	2437910	A1	4/1980
FR	2649028	A1	1/1991
JP	3042199	A	2/1991
WO	98/47653		10/1998
WO	2004/091862	A2	10/2004
WO	2010/128131	A2	11/2010
WO	2012171732		12/2012
WO	2013152549		10/2013
WO	2014/193765		12/2014

**OTHER PUBLICATIONS**

Thorne & Derrick UK: "Generation Safety Plus;" [www.cablejoints.co.uk](http://www.cablejoints.co.uk); 16 pages.

International Search Report and Written Opinion for PCT/US2014/039473 mailed Oct. 3, 2014.

Office Action dated Jul. 2, 2014 for U.S. Appl. No. 13/449,821.

Response filed on Oct. 2, 2014 for Office Action dated Jul. 2, 2014 for U.S. Appl. No. 13/449,821.

Thorne & Derrick UK: "Generation Safety Plus;" [www.cablejoints.co.uk](http://www.cablejoints.co.uk); 16 pages.

EK 60 UNV-L Battery Powered universal tool 6-300 mm2; <http://www.klauke.com/katalog/en/ek-60-unv-l-11977>; 3 pages.

Written Opinion of the International Searching Authority dated Dec. 16, 2013 for PCT/EP2012/058767 filed May 11, 2012.

International Search Report completed Sep. 18, 2012 for PCT/EP2012/058767 filed May 11, 2012.

International Preliminary Report on Patentability dated Dec. 17, 2013 for PCT/EP2012/058767 filed May 11, 2012.

Response to Office Action filed Feb. 13, 2015 for U.S. Appl. No. 13/449,821.

International Search Report dated Oct. 3, 2014 for PCT/US2014/039473.

Office Action dated Mar. 13, 2015 for U.S. Appl. No. 13/449,821.

Response file Jun. 12, 2015 to Office Action dated Mar. 13, 2015 for U.S. Appl. No. 13/449,821.

Notice of Allowance dated Sep. 14, 2015 for U.S. Appl. No. 13/449,821.

Chinese Office Action dated May 27, 2015 for Chinese Application No. 201210194064.0.

\* cited by examiner

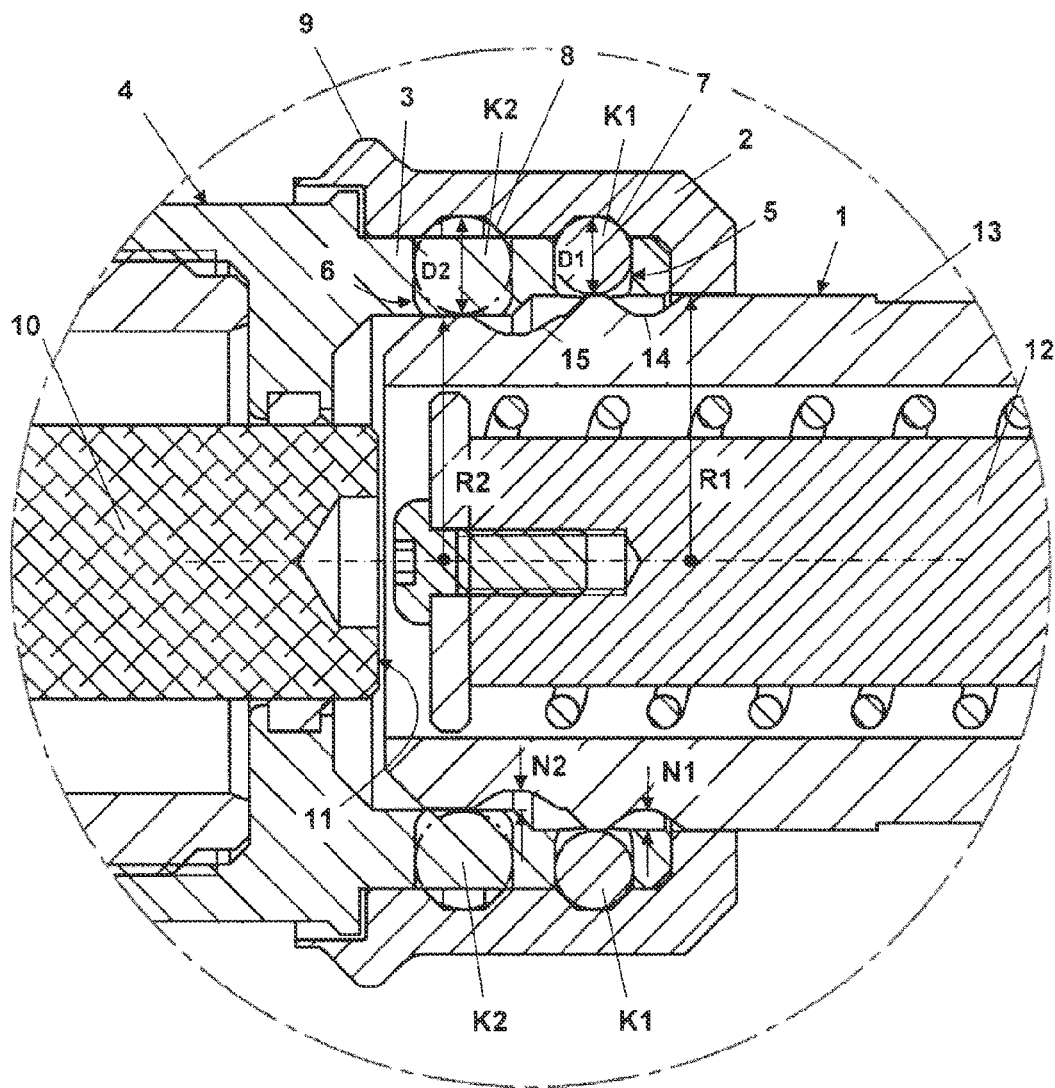


Fig. 1

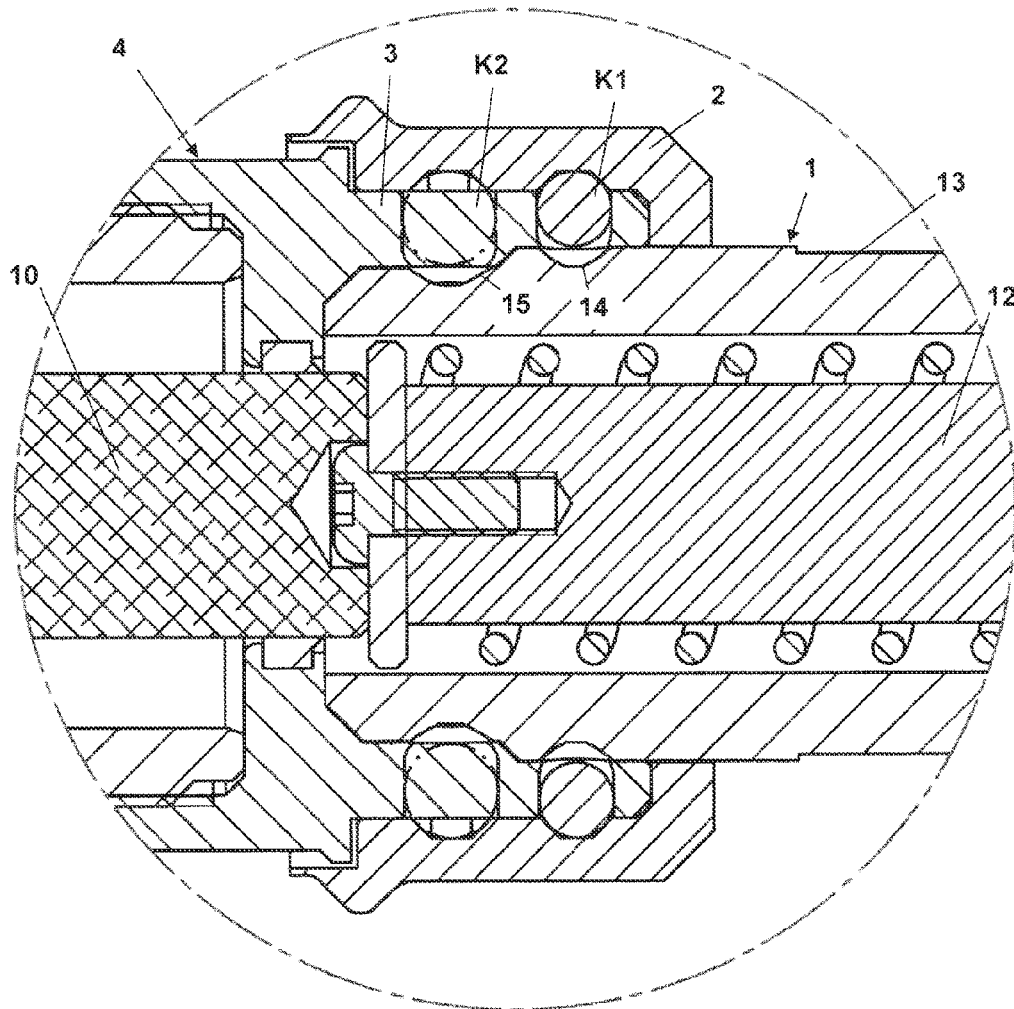


Fig. 2

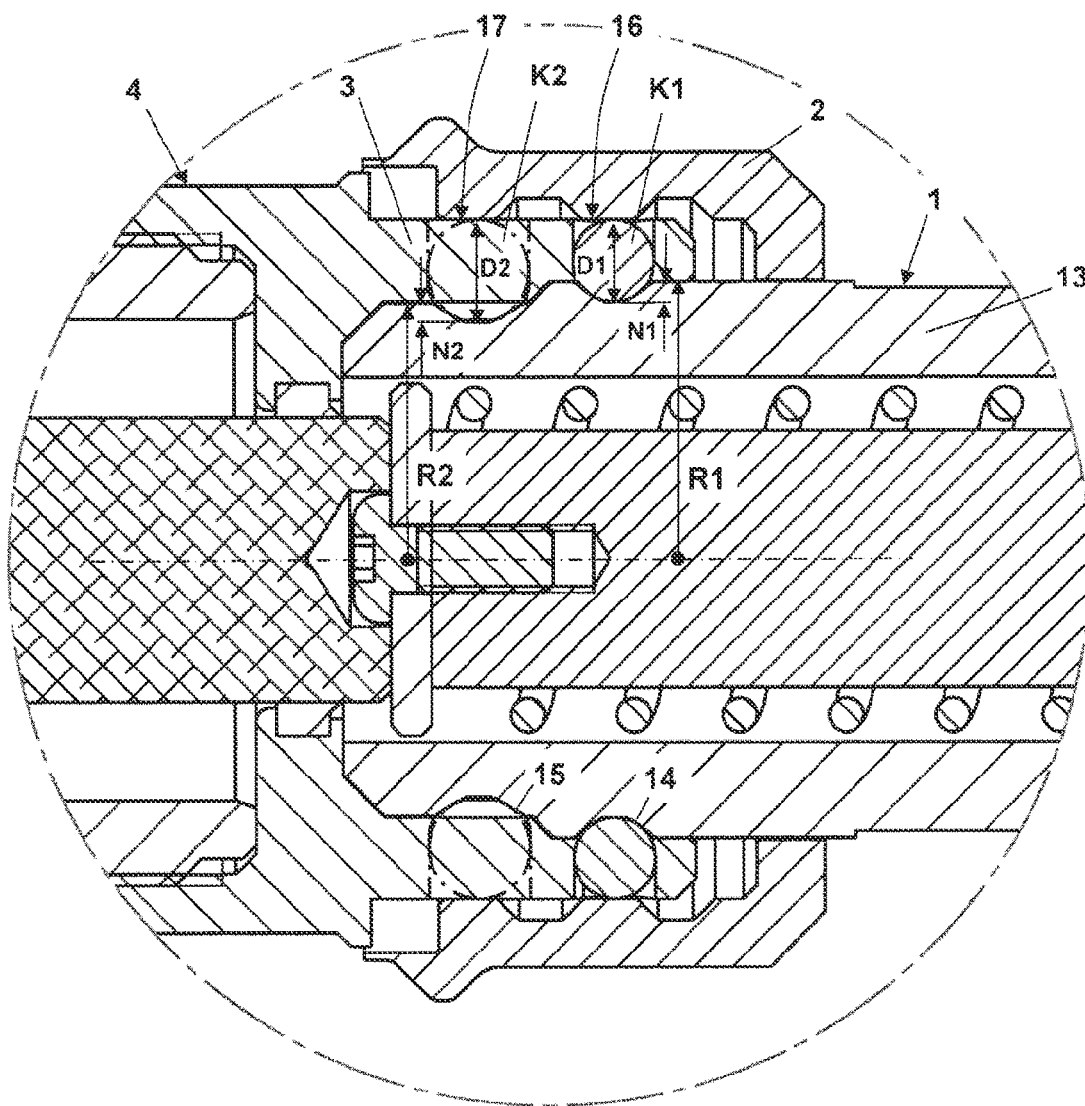
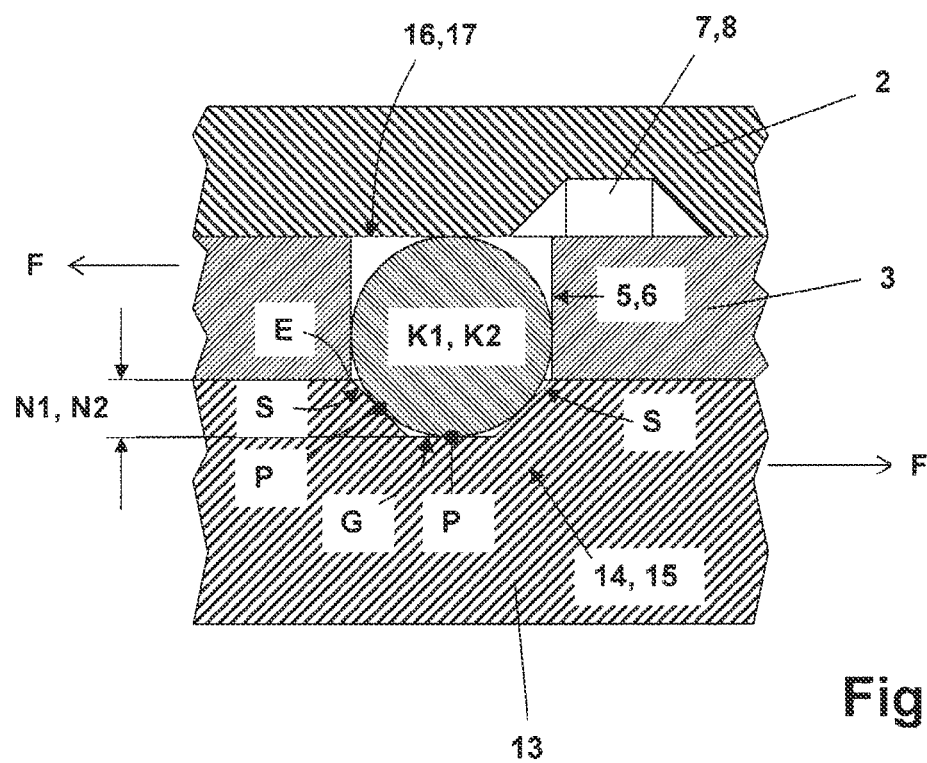
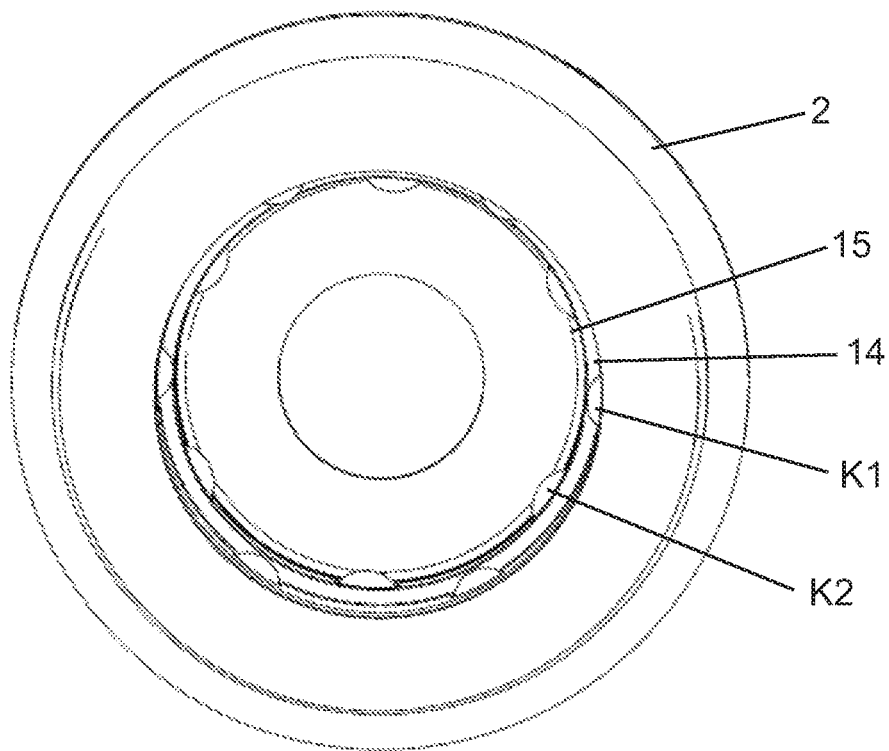


Fig. 3





**Fig. 5**

**QUICK-CONNECT COUPLING****CROSS REFERENCE TO RELATED APPLICATIONS**

This application claims priority to Swiss Patent Application No. CH-01006/11 filed Jun. 16, 2011 the contents of which are incorporated herein by reference.

**FIELD OF THE INVENTION**

The invention relates to a quick-connect coupling for connecting an exchangeable head to a pressing device.

**BACKGROUND OF THE INVENTION**

Pressing devices are used for various purposes, such as, for example, pressing cable shoes onto electrical cables, but also for cutting cables or punching holes into sheet metal constructions. In order to perform these different applications on one machine, an exchangeable head system is required. To simplify matters, the different mountable heads are referred to in the following as exchangeable heads. Using the same pressing device with different exchangeable heads, it is quick and easy to change over to different applications where necessary.

However, a particular problem affecting pressing devices with exchangeable heads is the longitudinal forces being transmitted, in other words, the compressive forces produced by the pressing devices, because the coupling mechanism by which the exchangeable head is attached to the pressing device naturally has to withstand these forces and the corresponding safety requirements are relatively high. It is advantageous, therefore, to find a coupling mechanism that can be handled quickly and easily and yet offers operational safety, even with high and very high longitudinal forces.

Quick-connect coupling mechanisms are known per se. A quick-connect coupling mechanism used particularly frequently for torque transmission, especially in the field of hand machine tools, employs a solution with movable locking bodies, usually balls, which engage with corresponding grooves in the exchangeable tool in the connected state. An example of this is known from DE-2 551 125, whereby percussion drills are held in a tool holder on a machine tool in an easily exchangeable manner. Although longitudinal forces are naturally also active here, these are compressive forces (seen in relation to the machine tool/tool connection), so that there is no risk of the quick-connect coupling being released under load by the longitudinal forces and thereby representing a safety risk.

However, solutions are also known in which the same functional principle is also used with quick-connect couplings, where longitudinal forces are active, which represent traction forces in relation to the parts being connected. An example of this sort of connection is disclosed in DE-1 108 528. This specification shows a valve coupling for hose lines and pipelines. In this case, a coupling sleeve exhibits radial wall bores in which radially movable balls are disposed, which may project into a peripheral groove of a coupling plug. A spring-mounted locking sleeve prevents the balls from slipping out of the peripheral groove. Because this is an application in which pressurised fluids are conducted through connectable lines, although there is a certain safety risk, because evidently no applications involving very high fluid pressures are envisaged, additional measures do not seem necessary.

The situation is different, however, when the same functional principle is to be used in a quick-connect coupling to connect an exchangeable head to a powerful pressing device. Because relatively high pressures are used in this case (for example >50 kN), special additional measures are needed in order to guarantee safety and reliability.

**SUMMARY OF THE INVENTION**

It is an object of the present disclosure, therefore, to indicate a quick-connect coupling with loading capacity to connect an exchangeable head to a pressing device, wherein the quick-connect coupling is based on the known construction principle with movable locking bodies in the form of balls, which engage in corresponding grooves in an exchangeable head in the coupled state. This quick-connect coupling should endure high longitudinal traction forces on a sustained basis and, if possible, without wear and guarantee a high degree of safety.

A further object involves the quick-connect coupling specified being designed in such a way that it is impossible for the pressing device and the interchangeable head to be wrongly assembled.

The present disclosure involves in principle the use in a generic quick-connect coupling of a further peripheral groove on the exchangeable head, on the one hand, and a greater number of locking bodies (balls) and also balls of different sizes, and, on the other hand, the further peripheral groove disposed closer to the pressing device being dimensioned with the associated locking bodies (balls), such that it is impossible to use the exchangeable head if it is wrongly positioned.

In accordance with the disclosure, a generic quick-connect coupling between a first and a second component should be taken to mean the following in this case: In a ball-holding part on a first component (in this case the pressing device), a number of balls K1 with a diameter D1 is radially movably disposed. On a second component (in this case the exchangeable head) a peripheral groove with a groove depth N1 to partially hold the balls K1 is present on a shaft part in an area with a shaft radius R1 with the first and second components in a connected state. In this case, a locking ring is movably attached to the ball-holding part in an axial direction and in a spring-mounted manner, the balls K1 being held radially fixed in the peripheral groove by said locking ring when the first and second component are in the connected state.

More particularly, in accordance with the present disclosure, it is provided that:—on the shaft section of the second component (exchangeable head) in an area with a further shaft radius R2, which is smaller than the shaft radius R1, there is a further peripheral groove with a further groove depth N2 and the further peripheral groove is disposed closer to the first component (pressing device) in an axial direction,

the further peripheral groove is designed to hold part of further balls K2 with a further diameter D2, wherein the further balls K2 are likewise disposed in a radially movable manner in the ball-holding part and wherein the further diameter D2 is greater than the diameter D1, and

the diameter D1 of the balls K1 is the same as or smaller than the difference between the diameter D2 of the further balls K2 and the further groove depth N2.

By using a further peripheral groove and with the associated use of a larger number of locking bodies (balls), as well as with balls of different sizes, it is possible to achieve



the transmission of smaller forces per locking body (ball), or else the transmission of greater forces. The dimensions of the quick-connect coupling, i.e. particularly the dimensions of the balls K1, K2 and the groove depth N2, mean that if the exchangeable head is not completely inserted into the ball-holding part on the pressing device, a fixed connection cannot be made (in other words, a connection in which power is only transmitted across a single peripheral groove and the locking bodies engaging with it). Non-lockability in the event of incorrect assembly is notably important, because this is exactly what must be completely and reliably prevented, due to the associated risks (breakage of the quick-connect coupling when there is a build-up of pressure). The present disclosure has the added advantage that an embodiment functions purely mechanically and does not require electronic monitoring.

It has also emerged that with two peripheral grooves and a total of at least 12 balls—and of course using tool steels that are sufficiently hard and tough to avoid lasting deformation—the specified longitudinal forces in the region of 60 kN can be reliably transmitted.

Also advantageous is an angularly offset arrangement of the balls K1 in the peripheral groove compared with the balls K2 in the further peripheral groove. The forces can thereby be more effectively distributed over the entire cross-section.

A further advantage is also that an arrangement of the embodiment facilitates the unlimited twistability of the exchangeable head in relation to the pressing device.

A further measure that ensures that the quick-connect coupling is able to withstand high longitudinal traction forces on a sustained basis and with as little wear as possible, involves the peripheral grooves each being provided with a base surface and side faces, namely in such a way that the balls K1 and K2 have a point contact with the base surface and the side faces in the connected state and that the point contact with the side face is made roughly in the region of the half groove depth N1, N2. This means that the locating point of the balls is moved from the entry edge of the peripheral grooves sensitive to deformation towards the entry centre of the peripheral grooves, which significantly increases wear resistance.

#### BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present invention, and the attendant advantages and features thereof, will be more readily understood by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein:

FIG. 1 shows a sectional drawing of an exchangeable head partly inserted in the quick-connect coupling with the locking ring in an unlocked position;

FIG. 2 shows a sectional drawing of an exchangeable head completely inserted in the quick-connect coupling with the locking ring in an unlocked position;

FIG. 3 shows a sectional drawing of an exchangeable head completely inserted in the quick-connect coupling with the locking ring in a locked position;

FIG. 4 shows a sectional detail drawing of the quick-connect coupling for the theoretical shaping of the peripheral grooves; and

FIG. 5 shows a perspective view from above of the quick-connect coupling of FIGS. 1-3.

#### DETAILED DESCRIPTION OF THE INVENTION

As required, detailed embodiments are disclosed herein; however, it is to be understood that the disclosed embodi-

ments are merely examples and that the systems and methods described below can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present subject matter in virtually any appropriately detailed structure and function. Further, the terms and phrases used herein are not intended to be limiting, but rather, to provide an understandable description of the concepts.

The terms “a” or “an”, as used herein, are defined as one or more than one. The term plurality, as used herein, is defined as two or more than two. The term another, as used herein, is defined as at least a second or more. The terms “including” and “having,” as used herein, are defined as comprising (i.e., open language). The term “coupled,” as used herein, is defined as “connected,” although not necessarily directly, and not necessarily mechanically.

FIG. 1 shows a sectional drawing of an exchangeable head 1 partly inserted in the quick-connect coupling with a locking ring 2 in an unlocked position. In this case, the locking ring 2 and a ball-holding part 3 are parts of the quick-connect coupling, which are connected to a pressing device 4. In the ball-holding part 3, balls K1 with a diameter D1 and further balls K2 with a further diameter D2 are disposed in ball guides 5, 6 such that they are radially movable. The balls K1, K2 act as movable locking bodies. In addition, the balls K1, K2 and the ball guides 5, 6 are distributed over the periphery of the ball-holding part 3. Furthermore, the ball-holding part 3 has staggered internal radii, namely an area with a greater outside internal radius R1 in the area of the ball guides 5 and the balls K1 and an area with a smaller inside internal radius R2 in the area of the ball guides 6 and the other balls K2. Special shaping of the ball guides 5, 6 on the inside of the ball-holding part 3 prevents the balls K1, K2 from falling out when the exchangeable head 1 is not inserted or not inserted fully.

The locking ring 2 is mounted on the ball-holding part 3 in an axially movable manner. The locking ring 2 has locating grooves 7, 8 on the inside, which are formed so that the balls K1, K2 can move away into the locating grooves 7, 8 when the locking ring 2 is in the unlocked position—as shown here—and thereby avoid obstructing the insertion of the exchangeable head 1. Not shown is a spring element that is mounted between the ball-holding part 3 and the locking ring 2 and permanently presses the locking ring 2 in an axial direction into the locking position (see FIG. 3). In order to achieve the unlocked position of the locking ring 2, as shown, the locking ring 2 must therefore be moved into this position manually by means of a gripping bar 9.

Since the quick-connect coupling described creates a mechanically secure, but detachable connection between the pressing device 4 and the exchangeable head 1 and the pressing device 4 transmits compressive forces onto the exchangeable head 1, there is a plunger 10 within the pressing device 4, via which pressure is transmitted onto an axially spring-mounted connecting rod 12 within the exchangeable head 1 during operation by means of a contact surface 11 on the plunger tip. If this is the case, the quick-connect coupling is naturally exposed to high axial forces, which act as traction forces and pull the pressing device 4 and the exchangeable head 1 apart.

The exchangeable head 1 has a shaft part 13 with outside radii that are likewise staggered and adapted to the corresponding graduations in the ball-holding part 3, namely an area with a shaft radius R1 and an area with a further shaft radius R2. The shaft radii R1, R2 of the exchangeable head

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1 correspond to the inside radii R1, R2 of the ball-holding part 3, naturally with corresponding tolerances for an easy-to-handle sliding fit.

The shaft part 13 has a peripheral groove 14 with a groove depth N1 in the area of the shaft part 13 with the greater shaft radius R1. The peripheral groove 14 serves the partial holding of balls K1 with the pressing device 4 and the exchangeable head 1 in the connected state. The shaft part 13 has a further peripheral groove 15 with a groove depth N2 in the area of the shaft part 13 with the smaller shaft radius R2. The peripheral groove 15 serves to partially hold the balls K2 with the pressing device 4 and the exchangeable head 1 in the coupled state. The further peripheral groove 15 is disposed in the axial direction closer to the pressing device 4. In addition, the peripheral groove 14 and the further peripheral groove 15 naturally have the same axial spacing as the balls K1 and K2 in the ball-holding part.

Based on the sizes introduced, it can also be said that the proposed structural form meets the following general condition:  $R1-N1+D1=R2-N2+D2$ . This defines the context in which the condition formulated below for preventing incorrect assembly is to be understood (particularly evident from FIG. 3).

It is also true that with a structure of the type shown with the diameters D1 of the balls K1 should be equal to or smaller than the difference between the diameter D2 of the further balls K2 and the further groove depth N2; in other words,  $D1 \leq D2 - N2$ . This condition means that no connection can be made between the exchangeable head 1 and the pressing device 4, in which the transmission of force only takes place via a single peripheral groove and the locking bodies (balls) engaging with it. If this condition is met, even in a case where the exchangeable head 1 is only inserted far enough for the other peripheral groove 15 to be located in the area of the balls K1—a position in which the locking ring 2 can be pushed into the locking position—no fixed connection can be made between the exchangeable head 1 and the pressing device, because the balls K1 can then still move way and are not fixable in the further peripheral groove 15.

FIG. 2 shows a sectional drawing of an exchangeable head 1 completely inserted in the quick-connect coupling with the locking ring 2 in an unlocked position. It is made clear here that both the balls K1 and the further balls K2 can be slipped into the peripheral groove 14 or further peripheral groove 15 provided for them in each case following complete insertion of the exchangeable head 1 (and partly, although not shown here, also under the effects of gravity). However, the exchangeable head 1 is not yet locked in this position, because the balls K1, K2 can still move away into the locating grooves 7, 8 provided for this in the locking ring, when the exchangeable head 1 is pulled out again. In the position shown, the locking ring 2 can be inserted, however, or it will do this automatically, if the locking ring is released, under the effects of the spring force mentioned earlier.

FIG. 3 shows a sectional drawing of an exchangeable head 1 completely inserted in the quick-connect coupling with the locking ring 2 in a locked position. It is made clear here that both the balls K1 and the further balls K2 are fixed in their radial position by stopping surfaces 16, 17 on the locking ring following complete insertion of the exchangeable head 1 and the advancing of the locking ring 2, such that they have no more freedom of movement and the exchangeable head is therefore locked. The balls K1, K2 now engage as a fixed locking body both with the shaft part 13 and also with the ball-holding part 3 and therefore prevent reciprocal movement.

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FIG. 4 shows a detail of a sectional drawing of the quick-connect coupling for the theoretical shaping of the peripheral grooves. The state shown corresponds section-by-section to that shown in FIG. 3, but is the same in principle for both peripheral grooves 14, 15. It is evident here that the peripheral grooves each display a base surface G and side faces S, namely, such that the balls K1, K2 have a point contact with the base surface G and the side face S at locating points P in the connected state and the point contact with the side face occurs in the area of the half groove depth N1, N2. In order to achieve the latter, the side faces S may also be divided into several curve sections and neither is it necessary for the individual curve sections to be straight lines. Under load, pressure is therefore transmitted to the contact points P on the side faces S. The entry edges E of the peripheral grooves 14, 15 sensitive to deformation therefore remain unloaded.

However, in order to keep the permanent deformation by balls K1, K2 as small as possible with the great forces anticipated F, tests have revealed that the hardness of the steel used for the shaft part 13 of the exchangeable head 4, for the ball-holding part 3 and for the locking ring 2 must be at least 60 HRC. Apart from the high hardness level, the steels used must also exhibit adequate toughness.

FIG. 5 is a perspective view from above of the quick-connect coupling of FIGS. 1-3. FIG. 5 shows the angularly offset arrangement of the first plurality of balls (K1) in the first peripheral groove as compared to the second plurality of balls (K2) in the second peripheral groove. FIG. 5 additionally shows the first and second peripheral grooves with an arrangement of 12 balls.

It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described herein above. In addition, unless mention was made above to the contrary, it should be noted that all of the accompanying drawings are not to scale. A variety of modifications and variations are possible in light of the above teachings without departing from the scope and spirit of the invention.

All references cited herein are expressly incorporated by reference in their entirety. In addition, unless mention was made above to the contrary, it should be noted that all of the accompanying drawings are not to scale. There are many different features to the present invention and it is contemplated that these features may be used together or separately. Thus, the invention should not be limited to any particular combination of features or to a particular application of the invention. Further, it should be understood that variations and modifications within the spirit and scope of the invention might occur to those skilled in the art to which the invention pertains. Accordingly, all expedient modifications readily attainable by one versed in the art from the disclosure set forth herein that are within the scope and spirit of the present invention are to be included as further embodiments of the present invention.

#### REFERENCE LIST

- 1 Exchangeable head
- 2 Locking ring
- 3 Ball-holding part
- 4 Pressing device
- 5 Ball guide
- 6 Ball guide
- 7 Locating groove
- 8 Locating groove
- 9 Gripping bar

10 Plunger  
 11 Contact surface  
 12 Connecting rod  
 13 Shaft part  
 14 Peripheral groove  
 15 Further peripheral groove  
 16 Stopping surface  
 17 Stopping surface  
 K1 Balls  
 K2 Further balls  
 D1 Diameter of the balls  
 D2 Diameter of the other balls  
 N1 Groove depth of the peripheral groove  
 N2 Groove depth of the further peripheral groove  
 R1 Shaft radius  
 R2 Further shaft radius  
 G Base surface of a peripheral groove  
 S Side face of a peripheral groove  
 P Locating point in the peripheral groove  
 E Insertion edge of the peripheral groove  
 F Axial force

What is claimed is:

1. A quick-connect coupling for connecting an exchangeable head to a pressing device, the quick-connect coupling comprising:

- a first plurality of balls, each ball of the first plurality of balls having a diameter D1;
  - a ball-holding part located on the pressing device, the first plurality of balls radially movably disposed therein;
  - a locking ring movably attached to the ball-holding part in an axial direction, the locking ring having a locked position and an unlocked position;
  - a first peripheral groove in a shaft part of the exchangeable head, the first peripheral groove having a depth N1 to partially hold the first plurality of balls and the shaft part at the first peripheral groove having a shaft radius R1 when the exchangeable head and the pressing device are in a connected position and the locking ring is in the unlocked position;
  - a second plurality of balls, each ball of the second plurality of balls having a diameter D2 greater than D1; and
  - a second peripheral groove in the shaft part of the exchangeable head disposed closer to the pressing device in an axial direction than the first peripheral groove, the second peripheral groove having a depth N2 to partially hold the second plurality of balls radius when the exchangeable head and the pressing device are in a connected position and the locking ring is in the unlocked position; the shaft part at the second peripheral groove having a shaft radius R2 less than R1;
- wherein the diameter D1 of the first plurality of balls is equal to or less than a difference of the diameter D2 of the second plurality of balls and the depth N2 of the second peripheral groove so that the first plurality of balls are positionable to move away from the shaft and are not fixable in the second peripheral groove such that no fixed connection can be made between the exchangeable head and the pressing device.

2. The quick-connect coupling according to claim 1, wherein structural form of the quick-connect coupling meets a condition of  $R1 - N1 + D1 = R2 - N2 + D2$ .

3. The quick-connect coupling according to claim 1, wherein structural form of the quick-connect coupling meets a condition of  $D1 \leq D2 - N2$ .

4. The quick-connect coupling according to claim 1, wherein the first plurality of balls and the second plurality of balls includes a total of at least 12 balls.

5. The quick-connect coupling according to claim 4, wherein the first plurality of balls are disposed angularly offset in the first peripheral groove compared to the second plurality of balls in the second peripheral groove.

6. The quick-connect coupling according to claim 4, wherein the first peripheral groove and the second peripheral groove each have a base surface G and side faces S and the balls of the first plurality of balls and the balls of the second plurality of balls have contact points with the base surface G and the side faces S in the connection position, in which the contact points with the side faces S are made at half depth of the first peripheral groove and at half depth of the second peripheral groove when the exchangeable head and the pressing device are in a connected position and the locking ring is in the unlocked position.

7. The quick-connect coupling according to claim 6, wherein the side faces S are divided into a plurality of sections or into a plurality of curved sections.

8. The quick-connect coupling according to claim 1, wherein the first plurality of balls are disposed angularly offset in the first peripheral groove compared to the second plurality of balls in the second peripheral groove.

9. The quick-connect coupling according to claim 8, wherein the first peripheral groove and the second peripheral groove each have a base surface G and side faces S and the balls of the first plurality of balls and the balls of the second plurality of balls have contact points with the base surface G and the side faces S in the connection position, in which the contact points with the side faces S are made at half depth of the first peripheral groove and at half depth of the second peripheral groove when the exchangeable head and the pressing device are in a connected position and the locking ring is in the unlocked position.

10. The quick-connect coupling according to claim 9, wherein the side faces S are divided into a plurality of sections or into a plurality of curved sections.

11. The quick-connect coupling according to claim 1, wherein the first peripheral groove and the second peripheral groove each have a base surface G and side faces S and the balls of the first plurality of balls and the balls of the second plurality of balls have contact points with the base surface G and the side faces S in the connection position, in which the contact points with the side faces S are made at half depth of the first peripheral groove and at half depth of the second peripheral groove when the exchangeable head and the pressing device are in a connected position and the locking ring is in the unlocked position.

12. The quick-connect coupling according to claim 11, wherein the side faces S are divided into a plurality of sections or into a plurality of curved sections.

13. A quick-connect coupling for connecting an exchangeable head to a pressing device, the quick-connect coupling comprising:

- a first plurality of balls, each ball of the first plurality of balls having a diameter D1;
- a ball-holding part located on the pressing device, the first plurality of balls radially movably disposed therein;
- a locking ring movably attached to the ball-holding part in an axial direction, the locking ring having a locked position an unlocked position;
- a first peripheral groove in a shaft part of the exchangeable head, the first peripheral groove having a depth to partially hold the first plurality of balls and the shaft part at the first peripheral groove having a shaft radius

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- R1 when the exchangeable head and the pressing device are in a connected position and the locking ring is in the unlocked position;
- a second plurality of balls, each ball of the second plurality of balls having a diameter D2 greater than D1; and
  - a second peripheral groove in the shaft part of the exchangeable head disposed closer to the pressing device in an axial direction than the first peripheral groove, the second peripheral groove having a depth to partially hold the second plurality of balls radius when the exchangeable head and the pressing device are in a connected position and the locking ring is in the unlocked position; the shaft part at the second peripheral groove having a shaft radius R2 less than R1;
- wherein the first peripheral groove and the second peripheral groove each have a base surface G and side faces S and the balls of the first plurality of balls and the balls of the second plurality of balls have contact points with the base surface G and the side faces S in the connection position, in which the contact points with the side faces S are made at half depth of the first peripheral groove and at half depth of the second peripheral groove when the exchangeable head and the pressing device are in a connected position and the locking ring is in the unlocked position; and
- wherein the diameter D1 of the first plurality of balls is equal to or less than a difference of the diameter D2 of the second plurality of balls and the depth of the second peripheral groove so that the first plurality of balls are positionable to move away from the shaft and are not fixable in the second peripheral groove such that no fixed connection can be made between the exchangeable head and the pressing device.
14. The quick-connect coupling according to claim 13, wherein the first plurality of balls and the second plurality of balls includes a total of at least 12 balls.
15. The quick-connect coupling according to claim 13, wherein the first plurality of balls are disposed angularly offset in the first peripheral groove compared to the second plurality of balls in the second peripheral groove.
16. The quick-connect coupling according to claim 13, wherein the side faces S are divided into a plurality of sections or into a plurality of curved sections.
17. A quick-connect coupling for connecting an exchangeable head to a pressing device, the quick-connect coupling comprising:

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- a first plurality of balls, each ball of the first plurality of balls having a diameter D1;
  - a ball-holding part located on the pressing device, the first plurality of balls radially movably disposed therein;
  - a locking ring movably attached to the ball-holding part in an axial direction, the locking ring having a locked position and an unlocked position;
  - a first peripheral groove in a shaft part of the exchangeable head, stopping surfaces of the locking ring radially fixing the first plurality of balls in the first peripheral groove when the exchangeable head and the pressing device are in a connected position and the locking ring is in the locked position such that a fixed connection is formed between the exchangeable head and the pressing device;
  - a second plurality of balls, each ball of the second plurality of balls having a diameter D2 greater than D1; and
  - a second peripheral groove in the shaft part of the exchangeable head disposed closer to the pressing device in an axial direction than the first peripheral groove, the stopping surfaces of the locking ring radially fixing the second plurality of balls in the second peripheral groove when the exchangeable head and the pressing device are in a connected position and the locking ring is in the locked position such that a fixed connection is formed between the exchangeable head and the pressing device;
- wherein the diameter D1 of the first plurality of balls is equal to or less than a difference of the diameter D2 of the second plurality of balls and the depth N2 of the second peripheral groove so that the first plurality of balls are positionable to move away from the shaft and are not fixable in the second peripheral groove such that no fixed connection can be made between the exchangeable head and the pressing device;
- wherein when the locking ring is moved from the locked position to the unlocked position the first plurality of balls move away from the exchangeable head such that the fixed connection between the exchangeable head and the pressing device is broken.
18. The quick-connect coupling according to claim 17, wherein the first plurality of balls and the second plurality of balls includes a total of at least 12 balls.

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